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Manual for the Program B&KNOISE (version 2.0)

Sandra Tavener

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Manual for the Program B&KNOISE (version 2.0)

Sandra Tavener

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Aeronautical and Maritime Research Laboratory

DSTO-GD-0023

ABSTRACT

The installation, control and outputs of the program B&KNOISE are described. B&KNOISE is a program designed to analyse sea noise or any other quasi-stationary signal. The program was designed to be user friendly and uses menus to take the operator through the analysis stages. Control of a Bruel and Kjaer 2131 spectrum analyser is handled by B&KNOISE and calculation of the mean and standard deviation are also performed by the program. The output is a number of files that contain the calculated information. Graphs can also be produced by the program.

RELEASE LIMITATION

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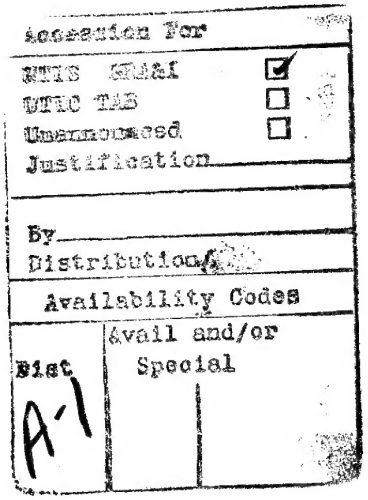

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CONTENTS

1. Introduction

B&KNOISE is an ambient sea noise processing program designed to be user friendly. Although it was developed specifically for the analysis of sea noise it could be used for the analysis of any other quasi-stationary signal.

The program works by setting up and controlling the Bruel and Kjaer spectrum analyser according to choices made by the operator. Choices are made through menus and encourage the operator to go through the stages in a particular order. After the setup is complete B&KNOISE triggers the spectrum analyser to sample over the selected averaging time in one third octave bands. The detected levels on the spectrum analyser are passed on to the computer where the mean and standard deviation are calculated and stored in file form. Many measurements of noise spectra, at fixed time intervals, are possible.

B&KNOISE was written by Sandra Tavener, mainly using the language Microsoft FORTRAN V5.0. A small routine was written in Microsoft C V6.0 to determine if the keyboard was struck. In FORTRAN V5.0 this function was not possible without either displaying a character on the screen or interrupting the processing of B&KNOISE. Using C V6.0 it was possible to perform this function totally in the background.

2. Operating instructions

Prior to running B&KNOISE the system must be set up correctly. This includes a connection between the computer and the Bruel and Kjaer 2131 spectrum analyser (B & K 2131). Once set up B&KNOISE is run by typing "B&KNOISE" at the DOS prompt, from the directory where B&KNOISE resides.

2.1 System Requirements

- Bruel and Kjaer 2131 Spectrum Analyser
- National Instruments GPIB-PCIIA interface card (in PC) and corresponding cable assembly and software
- Mechanism to play an analogue signal to the spectrum analyser (eg: tape recorder with an input cable assembly connected to the spectrum analyser)
- A postscript printer if hard copies of graphs are required

2.2 Installation

The installation of the complete system requires three stages. The first is the connection between the computer and the spectrum analyser. The second is a system

which passes the signal to be processed onto the spectrum analyser as an input. The final stage requires the installation and setup of the program B&KNOISE.

Computer interface to the spectrum analyser

The National Instruments GPIB-PCIIA card must be installed in the PC and connected to the spectrum analyser via an appropriate cable assembly. The GPIB software and hardware should be installed as described by the GPIB-PC User Manual. As indicated by the manual the configuration program, "IBCONF", must be run before use of the card.

The configuration program allows up to two boards and 16 devices per board to be setup. For the program B&KNOISE only one board is required with two devices. The board must be named "GPIB0". The first device must be called "BK2131L" (for the listen line). The second must be called "BK2131T" (the talk line). The board and each device must be set up. To do this select the item to setup, by highlighting it, and choose the option of **F8: EDIT** by pressing F8. A new screen will appear containing that particular device's characteristics.

The device characteristics required for BK2131L are:

Primary GPIB Address	17
Secondary GPIB Address	None
Timeout setting	10s
EOS Byte	00H
Terminate Read on EOS	no
Set EOI with EOS on Write	no
Type of compare on EOS	7-bit
Set EOI w/last byte of write	yes

The device characteristics required for BK2131T are the same except the "Primary GPIB Address" must be set to 16. If an address of a device is not set correctly B&KNOISE will not be able to find the device and will fail.

For the board the "Primary GPIB Address" must be zero. The other characteristics are as above. The extra characteristics, not required for the devices, are determined by the type of computer the system is working from. For the details about these extra characteristics see the GPIB-PC User manual.

Input signal to the spectrum analyser

The input to the Bruel and Kjaer spectrum analyser must be analogue. There are a variety of systems that can be used to provide the input signal. Two examples are:

1. Take the output from an analogue tape recorder and using the correct cable assembly connect to the input of the B & K 2131 spectrum analyser.

2. Take the output from a video recorder, where the data has been stored in digital form on the tape, and pass it through a pulse code modulator (PCM). This will transform the signal from digital to analogue form. Then using an appropriate cable assembly, pass the output of the PCM to the input of the B & K 2131 spectrum analyser.

Program B&KNOISE

The program B&KNOISE is installed by copying the files on the floppy disk to a hard disk. The program can be run from a floppy disk, but due to file handling running from a floppy disk will be slower.

No special directory name is required but all files read and written to, by the program, will be from the same directory.

The graphics library, PGPLOT, used to create the graphics, requires four environmental variables to be set before running B&KNOISE. The environment variables and their settings are:

PGPLOT_FONT = *dirname*\GRFONT.DAT
PGPLOT_PS_WIDTH=7568
PGPLOT_PS_HEIGHT=11193
PGPLOT_VIDEO=VGA16

where *dirname* is the full name of the directory where B&KNOISE resides, for example C:\B&KNOISE.

These variables can be set using the AUTOEXEC.BAT if B&KNOISE is used frequently.

If compiling and linking of B&KNOISE is required refer to the make file, B&KNOISE.MAK, and ensure all required libraries exist and are correctly pathed. In particular ensure the existence of the GPIB-PC DOS handler software and graphics library.

3. Principles of sea noise measurement

3.1 Generalised Sea Noise Measurement Setup

B&KNOISE was developed with the standard sea noise measurement and processing setup as its basis. As shown in figure 1 this setup comprises a hydrophone, a calibration signal, a recording system, the Bruel and Kjaer spectrum analyser and a number of possible amplifiers (represented by G).

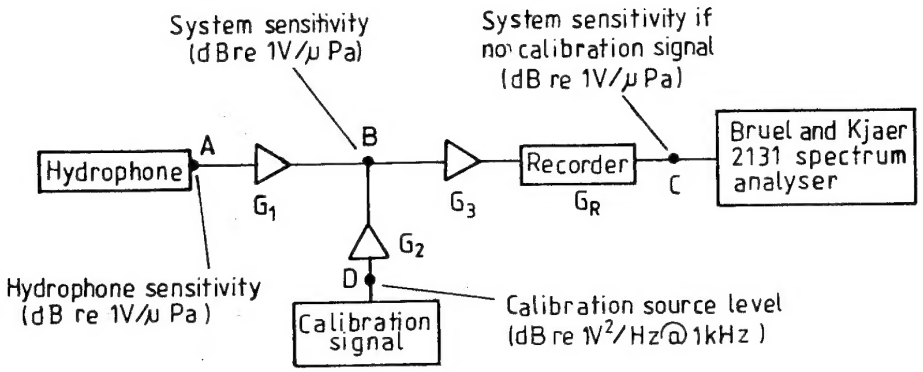

Figure 1 - Generalised system setup. Gains are in decibels.

3.2 *Calibration Signals*

Usually prior to obtaining a measurement of the sea noise a calibration signal is recorded on the tape in use. B&KNOISE is designed for a calibration signal of either white or pink noise. These are the standard calibration signals used for noise measurements because sounds in nature have similar characteristics to white or pink noise.

Because the purpose of the calibration signal is to calibrate the system, it would normally be inserted at the point where the hydrophone signal feeds into the system and measured at the point where the signal output is measured. The setup of Figure 1, however, allows for the possibility that different gains may be used for the signal (gain G_1) and the calibration (gain G_2) at the input.

White noise has a flat spectrum. The spectrum level is the same at all frequencies, see Figure 2. For full octave bands the level rises with increasing frequency by 3 dB per octave (1 dB per one third octave), as shown in Figure 3.

Pink noise has a spectrum which falls with increasing frequency by 3 dB per octave (1 dB per one third octave). The power spectrum is inversely proportional to frequency, as shown in Figure 2. For one third octave and full octave bands the levels are constant with frequency, as shown in Figure 3. The B & K 2131 spectrum analyser measures the signal level in octave or one third octave bands.

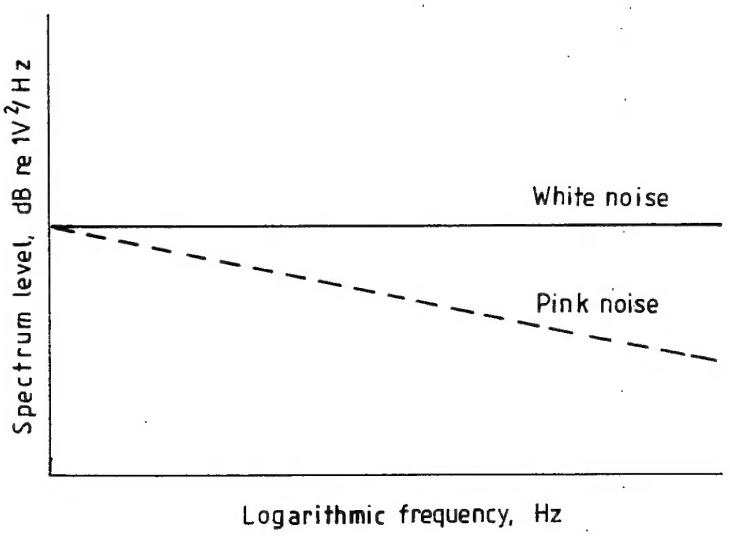

Figure 2 - Spectrum levels of White and Pink noise.

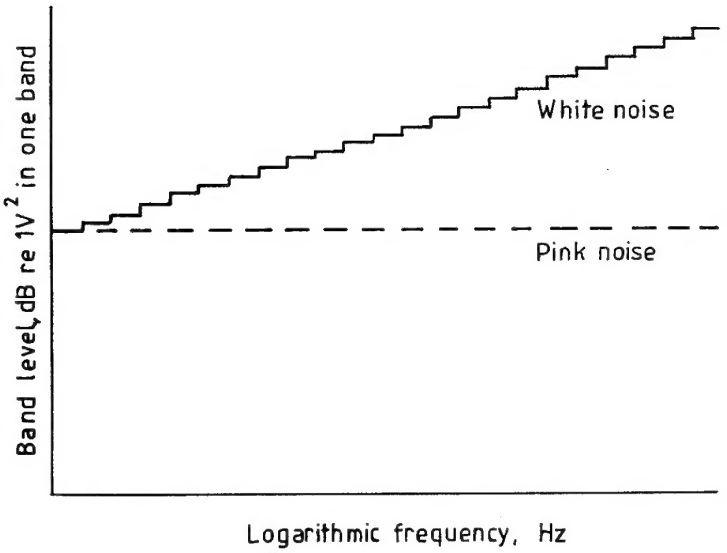

Figure 3 - Band levels of White and Pink noise.

Pink noise is more often used as the calibration signal because white noise has a greater chance of overloading a system. As the centre frequency of an octave band increases the frequency band covered also increases. For white noise, which has the same spectrum level at all frequencies, this leads to an increase in the band level as the centre frequency increases.

3.3 Sea Noise Measurement

After a calibration signal is stored a recording of the sea noise is taken and later processed through the B & K 2131. Processing of the sea noise involves sampling the sea noise, in the standard one third octave bands, at operator selected positions on the tape. Through B&KNOISE a "sample" is considered to be a single measurement, over the selected averaging time, obtained by the spectrum analyser. Consecutive samples are grouped into blocks, as shown in Figure 4. Blocks are separated by "wait times" chosen by the user.

A "block" refers to a group of consecutive samples with nominally zero wait time between each sample. This is effectively a 1s wait between samples to allow the spectrum analyser to reset.

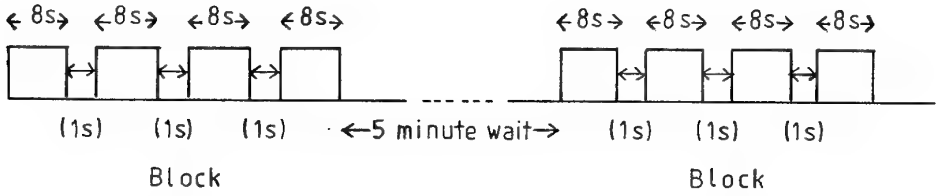

Figure 4 - Example of a BLOCK of four samples each of 8 seconds with a 5 minute wait time between blocks.

The B & K 2131 spectrum analyser requires time to measure the incoming data. For the measurement it can be set to record either the average level over a set time interval, with all incoming data in that time interval being weighted equally (the "linear" setting), or the running average level where the incoming data is exponentially weighted so that new data has greater influence (the "exponential" setting). For all the measurements in B&KNOISE the analyser has been set for linear averaging. Therefore the set time interval to obtain a sample is referred to as the "averaging time".

The result of each acquisition is passed on to the computer for further processing by B&KNOISE. There the mean and standard deviation for specific blocks at each of the one third octave frequencies are calculated and stored in an output file.

In the case where there is a delay between each sample, such as a one minute wait, each sample is considered to be a block. In this case, in the output file, the mean of

each block is equivalent to the level of its sample. The mean over all the blocks is not calculated for this situation.

3.4 Calculations

To calculate the correct mean and standard deviation for each block B&KNOISE requires information about the system. The set of information required by B&KNOISE contains the details of the measurement and the analysis parameters. Information such as the hydrophone sensitivity, the calibration signal level recorded, the gains in the system and the frequency range to acquire over, are obtained from the operator.

Figure 1 represents a generic sea noise measurement setup, which is assumed by B&KNOISE. As indicated in this figure, the "Calibration Source Level" is the level of the calibration signal inserted at point D. This signal is subject to a total gain (in decibels) of $G_2+G_3+G_R$.

The hydrophone sensitivity would be obtained at point A, as represented in Figure 1 and the sea noise signal would be subject to a total gain (in decibels) of $G_1+G_3+G_R$. If no calibration signal was recorded the hydrophone sensitivity value would include the record/play system's response, G_R, and the common gain in the system, G_3. Therefore the hydrophone sensitivity would be obtained at point C in Figure 1 and the sea noise signal would be subject to no gain.

If there is a calibration signal then the record/play system response is determined by B&KNOISE. This is done by comparing the calibration signal 'prior to recording' to the signal measured by the spectrum analyser.

After all the parameters are ascertained and a sample of the calibration signal is obtained sampling and calculation of the sea noise is commenced. The final results are determined by taking into account the parameters, including the system response and the different referencing levels of the individual signals.

The B & K 2131 returns levels dB re 1μV for each one third octave band. The referencing for the other signals is as indicated in Figure 1. B&KNOISE produces the mean and standard deviation of the sea noise dB re $1\mu Pa^2/Hz$. The procedure to produce the correct sea noise levels, for all measurement frequencies, per sample is indicated below.

The sea noise level is calculated using:

$$S_N = S_O - G_S - HP \qquad (1)$$

where

S_N = Sea noise level (dB re $1\mu Pa^2/Hz$)

S_O = Sample of sea noise measured on the B & K 2131 (dB re $1V^2/Hz$)

G_S = Total sea noise signal gain (dB)
HP = Hydrophone sensitivity (dB re $1V^2/\mu Pa^2$)

The total sea noise signal gain is composed of three components,

$$G_S = G_1 + G_3 + G_R \tag{2}$$

where

G_1 = the gain specific to the sea noise signal, referred to as the "Sea Noise Gain" in the Measurement Options menu
G_3 = the gain common to both the signal from the hydrophone and the calibration signal
G_R = the record/replay gain of the recording system

By recording and replaying a calibration signal through the system the common gains, G_3 and G_R, can be determined,

$$C_O = C_I + G_2 + G_3 + G_R \tag{3}$$

where

C_O = Calibration signal output as measured on the B & K 2131 (dB re $1V^2/Hz$),
C_I = Calibration source input at point D in Figure 1 (dB re $1V^2/Hz$), referred to as the "Calibration Source Level" in the Measurement Options menu
G_2 = the gain specific to the calibration signal, referred to as the "Calibration Gain" in the Measurement Options menu

Rearranging (3) gives

$$G_3 + G_R = C_O - C_I - G_2 \tag{4}$$

Substituting (4) into (2) gives the total sea noise signal gain in known or measurable terms

$$G_S = G_1 + C_O - C_I - G_2 \tag{5}$$

Substituting (5) into (1) gives the sea noise level in known or measurable terms

$$S_N = S_O - C_O + C_I - G_1 + G_2 - HP \tag{6}$$

However, both S_O and C_O are measured on the B & K 2131, whose output is dB re $1\mu V^2$/one third octave, so before they are used they must be transferred into the correct units of dB re $1V^2/Hz$.
Thus,

$$S_O = B\&K_S - 120 - BW \tag{7}$$

and $C_O = B\&K_C - 120 - BW$ (8)

where

$B\&K_S$ and $B\&K_C$ are the level of sea noise and calibration signal respectively, measured on the B & K 2131 (dB re 1μV²/one third octave) and transferred to the computer by B&KNOISE.

BW = bandwidth correction $= 10\log_{10}(0.23f)$, where f is the centre frequency (Hz) of the one third octave band.

Therefore, after substituting (7) and (8) into (6), the sea noise level is given by,

$$S_N = B\&K_S - B\&K_C + C_1 - G_1 + G_2 - HP \quad (9)$$

The final stage of B&KNOISE is the calculation of the mean and standard deviation as well as storing the results in a file. Standard statistical methods are used to calculate the mean and standard deviation.

4. Menus

B&KNOISE is controlled through menus. There are three menus used by the program with the structure as indicated in figure 5.

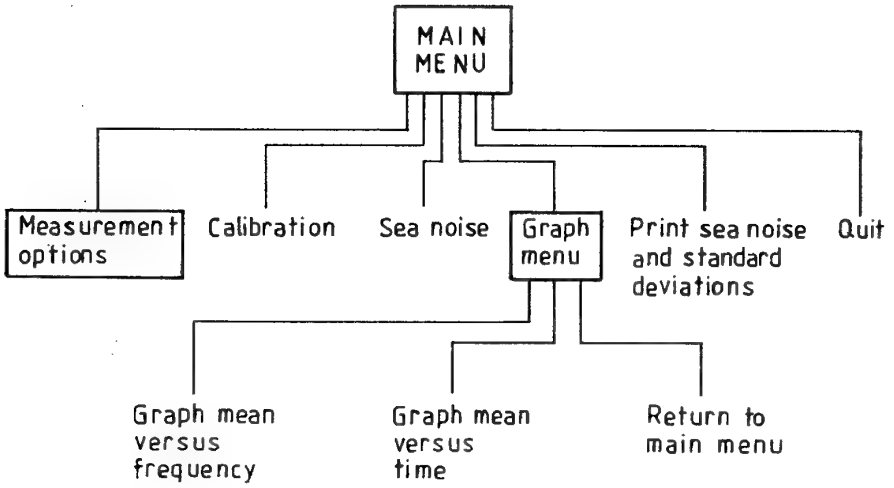

Figure 5 - Block diagram of menus. Items in boxes are menus, the remainder are operations.

4.1 Main Menu

The program begins with a Main Menu which encourages the user to go through the steps in a set order. A star is placed next to each step after completion. Figure 6 displays the Main Menu. For correct running of B&KNOISE the options should be selected in the same order as listed in the Main Menu. To make a selection the operator should type the number of the option required. An incorrect entry will result in a beep and the operator remaining in the Main Menu.

SEA NOISE PROCESSING USING BRUEL AND KJAER SPECTRUM ANALYSER 2131

MAIN MENU

1. CHECK/CHANGE MEASUREMENT OPTIONS

2. CALIBRATION

3. SEA NOISE

4. GRAPH SEA NOISE VERSUS FREQUENCY OR TIME

5. PRINT SEA NOISE AND STANDARD DEVIATIONS

6. QUIT

Your choice = _

Figure 6 - Main menu

Check/change measurement options

Selecting this step brings up a list, in the form of a menu, of the last sea noise processing parameters and uses these as the default parameters. In figure 5 this menu is referred to as the "Measurement Options". The user verifies or changes the settings according to the measurement to be made. At the end of this step the chosen values are stored and used as the default values the next time the program is run. Each time

B&KNOISE is run this option must be selected first so that the default values are loaded into the program. For details on the Measurement Options menu see section 4.2.

Calibration

This step allows the use of a white or pink noise signal, previously recorded on the tape in use, to be sampled as a calibration signal. For information about the calibration signal see section 3.2. For the details of the "Calibration" operation see section 4.3.

Sea noise

The aim of this step is to analyse the sea noise at selected locations on the tape. The mean and standard deviation, in one third octave bands, are calculated for these different locations. For information about the sea noise measurement see section 3.3. For the details of the "Sea noise" operation see section 4.4.

Graph sea noise versus frequency or time

This step places up another menu to allow the user to select either a graph of the mean versus frequency, or the mean versus time at a specific frequency. For details on the menu see section 4.5.

Print sea noise and standard deviations

This step allows easy printing of the data stored in the main output file. See also section 4.6.

Quit

This step nicely exits the user from the program. See also section 4.7.

4.2 Measurement Options

The Measurement Options menu is a list of the analysis and measurement settings. It requires the operator to verify each setting or change incorrect settings. Figure 7 is the screen used by the operator.

To not change an entry the operator presses <ENTER>. This will move the cursor to the next choice. To change an entry the operator should type the value for that choice and then <ENTER> to move to the next choice.

SEA NOISE ACQUISITION USING B & K 2131

MEASUREMENT OPTIONS

Type value then <ENTER> or just <ENTER> for no change

NUMBER OF FREQUENCY CHANNELS USED ON B & K 2131	:	24	
FIRST CHANNEL NUMBER USED ON B & K 2131	:	15	*31.5 Hz*
AVERAGING TIME (s)	:	8	
NUMBER OF SAMPLES PER BLOCK	:	6	
TOTAL NUMBER OF BLOCKS	:	4	
TIME BETWEEN EACH BLOCK (s)	:	5	*AUTO TRIGGER*
CAL SOURCE, NONE (N), WHITE (W) OR PINK (P) NOISE	:	P	
CALIBRATION SOURCE LEVEL (dB re $1V^2/Hz$ @ 1kHz)	:	-130.0	
HYDROPHONE SENSITIVITY FILE	:	HYDROPHO.DAT	
CALIBRATION GAIN (dB)	:	0.0	
SEA NOISE GAIN (dB)	:	0.0	
TAPE LABEL (nnn/dd/mm/yy)	:	01A/24/03/92	
PLAY TAPE RECORDER PLANT NUMBER	:	2048	
GRAPHICS FILES? (Y/N)	:	Y	
MAIN OUTPUT FILE NAME	:	DEMO.DAT	

TOTAL TAPE PLAY TIME = 3 min 51 sec

E : Exit from routine

C : Change an entry : _

Figure 7 - Measurement Options 'menu'. Items in italics are only displayed after an entry has been updated.

Number of frequency channels used on B & K 2131

The Bruel and Kjaer spectrum analyser has 43 channels available. Each channel is pre-assigned a frequency band. The one third octave centre frequency that corresponds to each channel is listed in table 1. The number that is required for this

choice is the total number of consecutive channels to be used for the analysis. Non-consecutive channels cannot be used through B&KNOISE.

Channel number	Centre frequency (Hz)	Channel number	Centre frequency (Hz)
1	----	24	250.00
2	1.60	25	315.00
3	2.00	26	400.00
4	2.50	27	500.00
5	3.15	28	630.00
6	4.00	29	800.00
7	5.00	30	1000.00
8	6.30	31	1250.00
9	8.00	32	1600.00
10	10.00	33	2000.00
11	12.50	34	2500.00
12	16.00	35	3150.00
13	20.00	36	4000.00
14	25.00	37	5000.00
15	31.50	38	6300.00
16	40.00	39	8000.00
17	50.00	40	10000.00
18	63.00	41	12500.00
19	80.00	42	16000.00
20	100.00	43	20000.00
21	125.00		
22	160.00		
23	200.00		

Table 1 - Centre frequencies of Bruel and Kjaer spectrum analyser one third octave channels

First channel number used on B & K 2131

This is the channel number representing the lowest analysis frequency. See table 1 for the one third octave centre frequencies represented by each channel. The frequency represented by the channel will be displayed beside the entry.

The suitability of the selected values of the "Number of frequency channels used on B & K 2131" and the "First channel number used on B & K 2131" are tested at this point. If the combination is such that more than the spectrum analyser's maximum of 43 channels is required, (ie: the maximum frequency is exceeded), then the message "TOO HIGH" will appear next to this entry. The message will disappear followed by a beep after a few seconds. To fix the error reduce the "First channel number..." entry so that the number of channels in use can be accommodated. If necessary, when given the option, return to the top of the choices and change the entry for "Number of frequency channels used on B & K 2131".

Averaging Time (s)

The spectrum analyser works by taking a sample of the measurement over a set averaging time. The averaging time selected by the user should be no less than the minimum required for the lowest frequency being measured and must be a power of two to match the capabilities of the analyser. The possible settings are shown on the spectrum analyser. Table 2 indicates the minimum averaging time required for specific one third octave centre frequencies. Frequencies greater than those specified in the table can be accurately analysed with the spectrum analyser's minimum averaging time setting of 1/32 seconds, although B&KNOISE will not accept an averaging time less than one second. The entry made for this choice is checked for its suitability. An error will result in a beep and no change of the value.

Centre frequency (Hz)	Minimum averaging time (s)
1.60	4
2.00	4
2.50	2
3.15	2
4.00	1
5.00	1
6.30	1
8.00	1/2
10.00	1/2
12.50	1/2
16.00	1/4
20.00	1/4
25.00	1/4
31.50	1/8
40.00	1/8
50.00	1/8
63.00	1/16
80.00	1/16
100.00	1/16
125.00	1/16

Table 2 - Minimum averaging time required for valid data for one third octave centre frequencies.

Number of samples per block

This is the number of samples, of the specified averaging time, to obtain consecutively. (For a description of "averaging time" and "block" see section 3.3.)

Total number of blocks

The total number of blocks of measurements required to complete the analysis.

Time between each block (s)

This is the length of time, referred to as "wait time", of non-sampling time required between blocks of measurements. The program has the ability of either waiting the required time and re-commencing sampling after the specified wait time, called "automatic triggering", or the operator may inform the program when the required time has elapsed, called "manual triggering".

Automatic triggering is selected by entering a positive number no greater than 9999. Manual triggering is selected by entering a negative number no less than –9999. For manual triggering the time recorded as the wait time is the absolute value of the number entered. In both cases the choice made is indicated by either the words "auto trigger" or "manual trigger", respectively, next to the number entered.

Cal source, none (N), white (W) or pink (P) noise

This is the type of signal used as the calibration signal. The choices are either "N", for no calibration signal available, "W", for a white noise signal, or "P", for a pink noise signal. The letters entered may be either upper or lower case. Only these entries are allowed. Incorrect entries will result in a beep and no change of the selection. For information about calibration signals see section 3.2.

Calibration Source Level (dB re $1V^2/Hz$ @ 1kHz)

This is the spectrum level (dB re $1V^2/Hz$ @ 1kHz) of the calibration signal at 1 kHz at the input to the recording system. The value should be entered with a decimal point. The operator will be informed that this value will be ignored if no calibration signal was selected at Measurement Options - "Cal source, none (N), white (W) or pink (P) noise".

Hydrophone sensitivity file

The sensitivity of the hydrophone, as a function of frequency, must be stored in a file in the same directory as B&KNOISE. For this entry the name of the file containing the hydrophone sensitivity is required. An example of a hydrophone sensitivity file is contained in Appendix B. See also section 5.

The sensitivity contained in the file would normally be the value obtained at point A in figure 1. However the "System sensitivity", at point B in figure 1, may be used instead.

This would be necessary for cases where the hydrophone amplifier, G_1 in Figure 1, is included in the hydrophone sensitivity measurement. Thus the file would contain the value of the sum G_1+HP.

If there is no calibration signal available then the hydrophone sensitivity file should contain the system sensitivity at point C, "System sensitivity if no calibration", in Figure 1. So the response of the record/play system, the actual hydrophone sensitivity and any gains are all taken into account. The file would then contain values of the sum $G_1+G_3+G_R$+HP. This is because when there is no calibration signal available B&KNOISE assumes the system sensitivity, including effects of the record/play system, to be as stated in the hydrophone sensitivity file. See also section 3.4.

Calibration Gain (dB)

This is the known gain, if any, used to amplify the calibration signal before it is fed into the system at point B in Figure 1. The value should be entered with a decimal point and attenuation should be entered as a negative number. From Figure 1 the required gain is G_2.

Sea Noise Gain (dB)

This is the known gain, if any, of the sea noise signal prior to point B in Figure 1. From Figure 1 the required gain would be given by G_1. The value should be entered with a decimal point and attenuation should be entered as a negative number.

At this stage it is important to recall the setup used for the measurement and analysis. If the hydrophone sensitivity already takes into account the "Sea noise gain", G_1, then the entry for this parameter should be zero.

Tape Label (nnn/dd/mm/yy)

This is the label of the tape on which the signal is stored and being analysed from. "nnn" needs to be a number between 01 and 99, standing for the tape number, followed by a letter representing the side of tape being used. If the number is less than ten it must be preceded by a zero. "dd" stands for the day of the recording, "mm" the month of the recording and "yy" the year of the recording. For example the first tape, side A, used on 26th March, 1992, would be labelled as "01A/26/03/92". This labelling is required if graphs of the data, created by B&KNOISE, are to be labelled correctly.

Play tape recorder plant number

This is the plant number of the tape recorder used for playing the signal to the spectrum analyser. This number is used for later reference only.

Graphics files? (Y/N)

The normal output file created by B&KNOISE cannot be easily used by standard graphics packages such as EASYPLOT or GRAPHER because the file contains a lot of header information. If a graphics package will be used to create the plots of the data then the answer to this choice should be "Y". This will instruct B&KNOISE to create one file for each block. Each file will contain the mean versus frequency for a particular block. No header information is stored in these files. The names of the files are determined by the program. An example of this type of output file is contained in Appendix C. For further information see section 6.

Main output file name

This is the name of the main output file where all the calculated information and details of the analysis will be recorded. If the file already exists then the user is questioned whether to overwrite the file or not (OVERWRITE? (Y/N)). If overwriting is specified (answer is "Y") the user is sent to the next choice. If the user specifies not to overwrite the file (answer is "N") they are given the opportunity to change the name of the file. A different answer will result in the question being repeated.

After this choice the total tape play time for the analysis of the sea noise signal for all blocks and wait times (excluding the calibration signal) is displayed and the operator will be passed on to the next choice.

E: Exit From Routine / C: Change An Entry

The final choice given to the user is whether they wish to exit this stage, "E", or return to the top of the screen to correct any selections, "C".

A selection of "exit from the routine" will return the operator to the main menu, and "Check/change measurement options" will have a star beside it. If "change an entry" is selected the user will be returned to the top of the selections to allow changes.

4.3 Calibration

This step sets up the spectrum analyser for a calibration measurement. The calibration measurement is the analysis of a known signal with a known level that was recorded on the tape in use before sea noise was recorded on that tape. B&KNOISE allows for either a white or pink noise signal as the calibration signal or for no calibration signal. If the entry to the Measurement Options parameter "Cal source, none (N), white (W) or pink (P) noise" is "N" there will be a star next to this step and the step should be skipped. For further description about the calibration signals see section 3.2.

The calibration measurement is required to determine the record/play system's transfer function on the recorded signals. This information is later used to remove the record/play system's transfer function from the sea noise under analysis.

After selecting the Main Menu's - "Calibration" option, but prior to actually measuring the calibration signal, ensure the input attenuation of the spectrum analyser is set so that each channel of interest will display the data within the dynamic range of the spectrum analyser. To check this play the calibration signal into the B & K 2131 and set the input attenuation level on the spectrum analyser such that there are no overloads and each channel of interest is displaying data. An overload is indicated by a sudden increase in contrast on the spectrum analyser screen which quickly disappears. The spectrum analyser automatically takes into account the attenuation used and modifies the output accordingly. So the attenuation level used by the spectrum analyser does not need to be entered into B&KNOISE. If the attenuation level is not set correctly and a channel of interest does not display data on the screen zero will be returned to the computer giving incorrect results.

B&KNOISE takes control of the spectrum analyser for the calibration measurement. The averaging time of the calibration measurement is set to eight seconds and the averaging method to linear averaging. These cannot be changed by the user through B&KNOISE. Once the spectrum analyser is ready the user is requested to start the tape and press <ENTER>. Pressing <ENTER> will begin the calibration measurement. At this point the user should note the tape counter number as it will be required after the measurement. The program requests this number to be entered so that it can be recorded in the output file and the measurement redone accurately at a later date, if required. During the eight seconds of sampling the user should ensure the calibration signal does not overload the analyser and the signal is not corrupted by interference. If either of these do occur the calibration measurement should be repeated, this time ensuring the attenuation on the spectrum analyser is set correctly and a suitable selection of the calibration signal is obtained from the tape.

At the end of the calibration measurement (after eight seconds) the computer will automatically obtain the information from the analyser. To ensure the correct data is passed from the B & K 2131 to the computer stop the tape as soon as the B & K 2131 has ceased sampling. The computer will request the tape counter number for the beginning of the measurement after it has obtained the data from the B & K 2131.

After the collected data has been processed a graph of the record gain will be offered. This is a graph of the gain of the record/play system as calculated from the measured calibration signal. If the graph is selected (answer of "Y" to the question) the operator will also be given the option to obtain a hard copy.

The record gain versus frequency is stored in the output file CAL.DAT whether or not a graph is produced. Although this file exists the program does not read this file or use it to represent a calibration at a later stage. This is because a calibration should be done each day analysis is performed and for each new tape. The file exists only to

allow graphing of the record gain after exiting from B&KNOISE. The file CAL.DAT has the standard format that is read by graphics packages such as EASYPLOT and GRAPHER. An example of this file is contained in Appendix C. After the graphing option the user will be returned to the Main Menu and a star will be placed beside "2. Calibration". See section 6 for further details on CAL.DAT.

To redo the calibration, at any stage in the processing, return to the Main Menu and select "Calibration" again. All previous calibration information will be overwritten by the new measurement. Details on using one calibration measurement for a number of different sea noise measurements can be found in section 4.4.

4.4 Sea Noise

B&KNOISE will once again take control of the spectrum analyser and set it up according to the choices made by the user in the Measurement Options, for processing of a sea noise signal. After the analyser is ready the user should ensure the attenuation level is set correctly, using the same method as for the calibration signal (but using the sea noise signal instead of the calibration signal). When requested and when ready start the tape and press <ENTER>. The attenuation level does not need to be the same as that used for the calibration signal since the spectrum analyser will take account of this automatically. The tape recorder counter number should be noted at this point as it will be required later by B&KNOISE.

After the measurements begin the user only needs to listen to the tape to ensure that there are no cases of interference or corrupted data. If there are then pressing <ESC> will eventually cease the analysis and return the operator to the Main Menu. This will allow the user to redo the sea noise processing at a different position on the tape. A star is not placed next to this step, in the Main Menu, if the step is not completed.

At the end of each sample the elapsed time, with the block number and spectrum (sample) number, is displayed. If automatic triggering was selected then at the end of each block the computer will automatically wait the required time and then re-commence sampling. If manual triggering was selected the user will be requested for the tape counter number for the beginning of the block just measured. This will be recorded in the output file. The operator will then be requested to press <ENTER> when ready to begin the next block of sea noise measurements. Sampling will re-commence when the <ENTER> key is pressed. The time elapsed is displayed on the monitor but is not recorded by the computer.

When the B & K 2131 has ceased sampling, at the end of the complete measurement, turn the tape off to ensure the correct data is passed to the computer. After the computer receives all the information, if automatic triggering was used, the operator is asked for the beginning tape counter number. For manual triggering the tape counter number for the beginning of the last block measured is requested. The counter number

will be recorded in the output file. After this is entered the user will be returned to the Main Menu and a star will be placed next to '3. Sea noise'.

During this option all the required calculations are done and the information is stored in the user specified output file. Details of the measurement and analysis settings are stored followed by the sample number and time, plus mean and standard deviation of the sample values in each block for all frequencies.

Further measurements from the same tape can be obtained by selecting Main Menu - "Check/change measurement options" again and changing any required settings. To save the measurement that was just completed, the output file name should be changed. On completion of this option the choice of reusing the existing calibration is given. An answer of yes ('Y') will place a star next to the calibration option, indicating that that stage is complete. An answer of no ('N') will not place a star next to the calibration option, indicating it is still be to be done. As long as the program is not exited the calibration information will be retained and can be used again. Continue by selecting the next step as indicated by the stars (either " Sea Noise" or "Calibration").

4.5 Graph Menu

This menu allows the user to select one of two different ways to display the data in graph form. The choices are graph the mean versus frequency or graph the mean versus time at a specific frequency. Figure 8 shows the menu used. A selection is made by typing the number of the option that is required. An unavailable selection is represented by a beep and the operator remaining in the Graph Menu.

Hard copies are available and are setup so that they use the full resolution of the printer and not just the screen resolution as in a screen print. B&KNOISE assumes the printer is a postscript printer and sends the print commands to a file which must then be copied to the printer when B&KNOISE has been exited. The operator is asked for the file name when a printout is requested and confirmation is required if the file already exists.

At the end of displaying a graph the user is returned to the Graph Menu and may view another graph. This step can be implemented even if the program was not used to perform any processing of a sea noise signal. The program will test its arrays to determine if a measurement has been made. If the answer is 'no' then it will request the name of the file to graph the data from. The file required for this type of graphing is the main output file created by B&KNOISE.

SEA NOISE ACQUISITION USING B & K 2131

GRAPH MENU

1. GRAPH MEAN LEVELS VERSUS FREQUENCY

2. GRAPH MEAN LEVELS VERSUS TIME

3. RETURN TO MAIN MENU

Your choice = _

Figure 8 - Graph menu

Graph mean levels versus frequency

This selection will produce a graph of the mean versus frequency. If only one block was sampled then the mean will be graphed versus frequency. If more than one block of samples was obtained the user is asked which block should be graphed. The mid-time of that block will be displayed followed by a graph of the mean versus frequency. After the graph is displayed the user is asked whether a printout is required.

Graph mean levels versus time

This selection will produce a graph of the mean versus time at a specific frequency. The user is asked which frequency should be graphed. This input is tested to ensure the chosen frequency was one that was measured. If only one block of samples was measured the level of each sample versus time will be graphed. If there was more than one block of samples measured the mean of each block will be graphed versus time. Once again the user is given the option of creating a hard copy of the graph.

In the plot the separation of the blocks of data in time is determined by the "Time between each block (s)" setting in the Measurement Options menu. For manual triggering the time between each block is taken to be the absolute value of that entry and not the actual physical wait time since this is not recorded by the computer.

Return to main menu

As the title indicates this selection will return the operator to the Main Menu.

4.6 Print Sea Noise And Standard Deviations

This option allows easy printing of the data stored in the output file. The details concerning the analysis and the measurement are printed with the mean and standard deviation. If more than one block was sampled the user is requested to specify which block to print. Like the Graph Menu options this step can be used even though a measurement has not been performed during this run of the program. The user will be requested for the name of the file to obtain the data from.

4.7 Quit

This step exits the user from the program nicely. The screen is reset and the line to the spectrum analyser closed. This method of exiting is much preferred to using <CTRL C> which will not reset the spectrum analyser or the screen.

5. Input files

There are two input files required for running B&KNOISE. One, PARAM.DAT, is a program created file and does not need to be edited by the operator. The last set of parameters selected for the program are stored in this file. The file should only need user editing if B&KNOISE fails when trying to read this file. It is in ASCII form and takes a similar format to the Measurement Options menu. An example of this file is contained in Appendix A.

The second file contains the sensitivity of the hydrophone used during the experiment, referred to as the "Hydrophone sensitivity file" in the Measurement Options menu. The name of this file is set by the operator. The program requires the file to contain the sensitivity of the hydrophone (dB re 1V/μPa) as a function of the standard one third octave centre frequencies (table 1). The frequency range covered in this file should be no less than all the measurement frequencies. A greater frequency range is allowed as long as the measurement frequencies are included. If B&KNOISE discovers that the measurement one third octave centre frequencies have not been included an error message will appear indicating the fault and the program will crash. An example of the set out of this file is contained in Appendix B.

6. Output files

Three types of output files are created. The main output file contains the settings used for the measurement and analysis as well as the mean and standard deviation versus frequency for each block and each sample's level versus frequency. This file is created whenever a sea noise analysis is done. The second set of output files contain just the mean versus frequency for a particular block and will only be produced if the Measurement Options - "Graphics files? (Y/N)" is "Y ". The final type of output file contains the record gain versus frequency.

The name of the main output file is determined by the user in the Measurement Options menu. The file begins with a list of the settings used for the measurement and analysis. Following this information is the hydrophone sensitivity used for the analysis. The results of the analysis are next. The level of the results stored depend upon the analysis settings. For a single block case the mean and standard deviation versus frequency of the block are written next. Below this are each sample's level versus frequency.

For a case where there is more than one block of data, the mean of each block is written to the file in chronological order. The levels of each sample are not stored. If a number of blocks of data are analysed but each block contains only one sample then the "mean" will be equivalent to the level's of each sample and the standard deviation would be zero. Examples of the output files are contained in Appendix C.

In the second set of output files there is no heading information because they are meant for use with graphics packages that enable graphs to be produced, such as EASYPLOT or GRAPHER. The names of these files are based upon the tape number and block number of the data contained in the graph and take the form:

Bbb_ddmm.DAT

where the capital letters are always present and
bb = block number
dd = day of recording
mm = month of recording

The first column of this file contains the frequencies. The second column contains the mean for a particular block. The number of files created of this type depends upon the number of blocks used for analysis. A file is created for each block of data. An example of this output file is contained in Appendix C. Note, if more than one sea noise measurement is being obtained from the same day of recording and the information stored in these files is required for further use the files should be copied to other files to prevent the information being overwritten.

The final type of output file also has no header information. It contains the record gain versus frequency in the standard format that can be read from graphics packages such as EASYPLOT and GRAPHER. This file is called CAL.DAT by B&KNOISE and is created whenever a calibration measurement is completed.

The first column of the file contains the frequencies and the second column contains the measured record gain (dB). This file is meant for cases where graphs of the record gain are required outside of B&KNOISE. An example of this output file is contained in Appendix C. Note the name of this file does not change so only the last record gain measurement is retained in file form. To retain previously measured record gains copy CAL.DAT to a different file prior to running B&KNOISE.

Appendix A - Default values file

The name of the default value file is set as PARAM.DAT. It is an ASCII file that contains the last measurement and analysis settings used for the program. It is set out like the Measurement Options menu to aid in finding faults in the file. Below is an example PARAM.DAT file. Words in square brackets are for information only and would not be found in the file.

The important information in this file is not the description of each variable but the variable's position in the file and its value. The variables must lie at column 54 or after. If the wording of the description is not correct it will not effect the reading of the file and will be written correctly by B&KNOISE after running the program.

```
                                                    [Column 54 ]
                                                    [    ⇓     ]
Number of frequency channels used on B & K 2131      : 24
First channel number used on B & K 2131              : 17
Averaging time (s)                                   :   4
Number of samples per block                          :   4
Total number of blocks                               :   1
Time between each block (s)                          :  10
Cal source, none (N), white (W) or pink (P) noise    : P
Calibration source level (dB re 1V^2/Hz @ 1kHz)      : -130.0
Hydrophone sensitivity file                          : HYDROPHO.DAT
Calibration gain (dB)                                :   .0
Sea noise gain (dB)                                  :   .0
Tape label (nnn/dd/mm/yy)                            : 01A/26/03/92
Tape recorder plant number                           : 1234
Main output file name                                : OUTPUT.DAT
```

Appendix B - Hydrophone Sensitivity File

The hydrophone sensitivity file contains the hydrophone sensitivity as a function of frequency. The name of the file is specified by the operator in the Measurement Options menu and must be created by the operator.

B&KNOISE requires the data to begin on the first line of the file. The first column contains the one third octave centre frequencies. The second column contains the hydrophone sensitivity (dB re 1V/µPa). In the example below the hydrophone sensitivity is not frequency dependant. The comment below can be part of the file, as long as it is placed after a sensitivity value. The exclamation mark is not required, it has only been placed here to indicate that it is a comment. Also a set format of the columns is not required. As long as there is only one pair of data per line and the two values are separated by at least one space the file will be read. However, only a space can be used to separate the two values, commas or other delimiters are not permitted.

As indicated in this file the complete frequency range of the analyser is not required, only the range of frequencies used during analysis.

```
12.50       -195.0
16.00       -195.0
20.00       -195.0
25.00       -195.0
31.50       -195.0
40.00       -195.0
50.00       -195.0      ! This file contains the hydrophone
63.00       -195.0      ! sensitivity of a sea noise buoy
80.00       -195.0
100.00      -195.0
125.00      -195.0
160.00      -195.0
200.00      -195.0
250.00      -195.0
315.00      -195.0
400.00      -195.0
500.00      -195.0
630.00      -195.0
800.00      -195.0
1000.00     -195.0
1250.00     -195.0
1600.00     -195.0
2000.00     -195.0
2500.00     -195.0
3150.00     -195.0
4000.00     -195.0
5000.00     -195.0
6300.00     -195.0
8000.00     -195.0
10000.00    -195.0
12500.00    -195.0
16000.00    -195.0
```

Appendix C - Output File Examples

Below are examples of the possible forms of the output files. In all cases words in square brackets ([ ]) are for description only and would not appear in the created file. "Std Dev" stands for Standard Deviation.

An example of a main output file for a case of one block of data made up of four samples.

```
Sea noise levels from tape 1A 26/03/92

 Tape recorder                   : 1234
 Calibration spectrum level      : -130.0 (dB re 1V2/Hz @ 1kHz )
 Cal source, white, pink or none: Pink noise
 Hydrophone sensitivity file     : HYDROPHO.DAT
 Calibration gain                :   .0 (dB)
 Sea noise gain                  :   .0 (dB)
 Calibration started at counter  :    14 using an 8s sample
 Seanoise started at counter     :  100
 Total sea noise play time       : 000 min 20 s

 Number of channels              =  31
 Averaging time                  =   4 s
 Number of samples per block     =   4
 Total number of blocks          =   1
 Time between each block         =  10 s  (auto trigger)
 First channel                   =  11

 Hydrophone sensitivity
      Freq (Hz)     Sensitivity (dB re 1V/µPa)
        12.50       -195.00         16.00       -195.00
        20.00       -195.00         25.00       -195.00
        31.50       -195.00         40.00       -195.00
        50.00       -195.00         63.00       -195.00
        80.00       -195.00        100.00       -195.00
       125.00       -195.00        160.00       -195.00
       200.00       -195.00        250.00       -195.00
       315.00       -195.00        400.00       -195.00
       500.00       -195.00        630.00       -195.00
       800.00       -195.00       1000.00       -195.00
      1250.00       -195.00       1600.00       -195.00
      2000.00       -195.00       2500.00       -195.00
      3150.00       -195.00       4000.00       -195.00
      5000.00       -195.00       6300.00       -195.00
      8000.00       -195.00      10000.00       -195.00
     12500.00       -195.00           .00           .00

 Calculated mean and standard deviation
      Freq (Hz)     Mean (dB)       Std Dev
        12.50         76.40           .33
        16.00         74.35           .54
        20.00         74.38          1.08    [This is the
        25.00         72.19           .70    | mean for the
        31.50         70.54           .91    | complete
        40.00         69.80           .98    |measurement]
        50.00         68.50           .15
```

63.00	68.13	.71
80.00	67.06	.45
100.00	65.19	.48
125.00	65.05	.23
160.00	63.68	.40
200.00	63.53	.55
250.00	61.44	.33
315.00	60.94	.02
400.00	60.07	.29
500.00	58.93	.23
630.00	58.03	.02
800.00	56.79	.20
1000.00	55.92	.23
1250.00	54.75	.00
1600.00	53.98	.02
2000.00	52.98	.15
2500.00	51.99	.17
3150.00	50.81	.15
4000.00	49.50	.02
5000.00	48.73	.00
6300.00	47.73	.02
8000.00	46.59	.00
10000.00	46.12	.02
12500.00	44.55	.00

Noise levels for each channel in each 4s block.

1

12.50	75.95
16.00	74.28
20.00	73.91
25.00	72.44
31.50	70.44
40.00	70.60
50.00	68.43
63.00	68.73
80.00	67.29
100.00	65.72
125.00	65.25
160.00	63.88
200.00	63.01
250.00	61.44
315.00	60.94
400.00	59.70
500.00	58.73
630.00	58.03
800.00	56.89
1000.00	56.12
1250.00	54.75
1600.00	53.98
2000.00	53.21
2500.00	51.84
3150.00	50.74
4000.00	49.50
5000.00	48.73
6300.00	47.73
8000.00	46.59
10000.00	46.12
12500.00	44.55

[These are the levels for a particular sample]

2

12.50	76.65

16.00	74.28
20.00	73.41
25.00	73.04
31.50	71.74
40.00	70.60
50.00	68.43
63.00	67.33
80.00	66.69
100.00	65.02
125.00	64.85
160.00	63.88
200.00	63.41
250.00	61.04
315.00	60.94
400.00	60.10
500.00	58.73
630.00	58.03
800.00	56.49
1000.00	55.72
1250.00	54.75
1600.00	53.98
2000.00	52.91
2500.00	51.84
3150.00	50.74
4000.00	49.50
5000.00	48.73
6300.00	47.73
8000.00	46.59
10000.00	46.12
12500.00	44.55

3

12.50	76.35
16.00	75.08
20.00	74.31
25.00	71.84
31.50	69.54
40.00	69.40
50.00	68.43
63.00	67.73
80.00	67.59
100.00	65.42
125.00	65.25
160.00	63.08
200.00	63.41
250.00	61.44
315.00	60.94
400.00	60.10
500.00	59.13
630.00	58.03
800.00	56.89
1000.00	56.12
1250.00	54.75
1600.00	53.98
2000.00	52.91
2500.00	52.14
3150.00	50.74
4000.00	49.50
5000.00	48.73
6300.00	47.73
8000.00	46.59
10000.00	46.12

```
  12500.00      44.55

4
     12.50      76.65
     16.00      73.78
     20.00      75.91
     25.00      71.44
     31.50      70.44
     40.00      68.60
     50.00      68.73
     63.00      68.73
     80.00      66.69
    100.00      64.62
    125.00      64.85
    160.00      63.88
    200.00      64.31
    250.00      61.84
    315.00      60.94
    400.00      60.40
    500.00      59.13
    630.00      58.03
    800.00      56.89
   1000.00      55.72
   1250.00      54.75
   1600.00      53.98
   2000.00      52.91
   2500.00      52.14
   3150.00      51.04
   4000.00      49.50
   5000.00      48.73
   6300.00      47.73
   8000.00      46.59
  10000.00      46.12
  12500.00      44.55
```

An example of a main output file for a case of four blocks of data, each with five samples.

```
Sea noise levels from tape 3a 17/1/92

 Tape recorder                   : 1234
 Calibration spectrum level      : -130.0 (dB re 1V2/Hz @ 1kHz )
 Cal source, white, pink or none: Pink noise
 Hydrophone sensitivity file     : HYDROPHO.DAT
 Calibration gain                :    .0 (dB)
 Sea noise gain                  :    .0 (dB)
 Calibration started at counter :   10 using an 8s sample
 Seanoise started at counter     :   55
 Total sea noise play time       : 002 min 20 s

 Number of channels              =  31
 Averaging time                  =   4 s
 Number of samples per block     =   4
 Total number of blocks          =   5
 Time between each block         =  10 s  (manual trigger)
 First channel                   =  11
```

Hydrophone sensitivity

Freq (Hz)	Sensitivity (dB re 1V/µPa)		
12.50	-195.00	16.00	-195.00
20.00	-195.00	25.00	-195.00
31.50	-195.00	40.00	-195.00
50.00	-195.00	63.00	-195.00
80.00	-195.00	100.00	-195.00
125.00	-195.00	160.00	-195.00
200.00	-195.00	250.00	-195.00
315.00	-195.00	400.00	-195.00
500.00	-195.00	630.00	-195.00
800.00	-195.00	1000.00	-195.00
1250.00	-195.00	1600.00	-195.00
2000.00	-195.00	2500.00	-195.00
3150.00	-195.00	4000.00	-195.00
5000.00	-195.00	6300.00	-195.00
8000.00	-195.00	10000.00	-195.00
12500.00	-195.00	.00	.00

Calculated mean and standard deviation

Freq (Hz)	Mean (dB)	Std Dev	Levels at time 000:10min.
12.50	51.65	20.00	
16.00	53.28	23.09	
20.00	73.61	1.04	
25.00	68.34	.84	
31.50	63.94	.65	
40.00	67.70	.28	
50.00	69.85	.13	
63.00	62.75	.33	⌈These are the ⌉
80.00	62.96	.15	| mean levels for |
100.00	72.97	.93	⌊the first block ⌋
125.00	78.60	.73	
160.00	82.08	.47	
200.00	79.61	.30	
250.00	72.56	.48	
315.00	72.66	.42	
400.00	72.95	.06	
500.00	75.35	.56	
630.00	78.28	.57	
800.00	62.09	.49	
1000.00	61.24	.87	
1250.00	61.80	.88	
1600.00	65.00	2.11	
2000.00	59.68	1.14	
2500.00	57.89	1.05	
3150.00	56.06	1.17	
4000.00	55.40	1.22	
5000.00	53.43	1.23	
6300.00	52.20	.69	
8000.00	48.26	.67	
10000.00	46.09	.25	
12500.00	44.15	.14	

Noise levels at time 000:40 min.
Counter started at 55

12.50	41.65	.01	
16.00	33.28	23.09	
20.00	72.96	1.14	⌈These are the ⌉
25.00	68.21	.74	| mean levels for |
31.50	62.74	.71	⌊the second block⌋

40.00	67.75	.06
50.00	69.80	.12
63.00	62.93	.38
80.00	62.69	.18
100.00	70.12	.30
125.00	75.90	.31
160.00	80.48	.14
200.00	78.48	.10
250.00	71.01	.22
315.00	71.21	.17
400.00	71.80	.08
500.00	73.30	.25
630.00	76.35	.17
800.00	62.46	.52
1000.00	61.67	1.26
1250.00	60.00	1.48
1600.00	62.28	2.15
2000.00	58.11	1.05
2500.00	55.41	.56
3150.00	53.06	.32
4000.00	52.12	.85
5000.00	50.98	.54
6300.00	51.68	.71
8000.00	47.86	.57
10000.00	45.59	.05
12500.00	44.15	.20

Noise levels at time 001:10 min.
Counter started at 65

12.50	61.65	23.09	
16.00	53.53	23.39	
20.00	73.01	1.04	
25.00	68.36	.72	
31.50	63.09	.17	
40.00	67.45	.34	⌈ These are the
50.00	69.53	.18	| mean levels for
63.00	62.83	.20	⌊ the third block ⌋
80.00	62.79	.48	
100.00	68.92	.36	
125.00	74.87	.69	
160.00	79.90	.25	
200.00	77.98	.19	
250.00	70.24	.29	
315.00	70.39	.25	
400.00	71.10	.08	
500.00	72.20	.05	
630.00	75.53	.16	
800.00	60.66	1.11	
1000.00	59.62	.75	
1250.00	58.05	.64	
1600.00	60.58	1.96	
2000.00	55.23	1.04	
2500.00	52.59	.33	
3150.00	51.16	.70	
4000.00	51.20	.55	
5000.00	50.43	.87	
6300.00	49.50	.75	
8000.00	46.24	.48	
10000.00	44.64	.05	
12500.00	43.65	.12	

Noise levels at time 001:40 min.
Counter started at 75

12.50	41.65	.01	
16.00	63.28	20.00	
20.00	73.41	1.04	⌈ These are the ⌉
25.00	67.59	.70	| mean levels for |
31.50	62.26	.15	⌊ the fourth block ⌋
40.00	67.70	.21	
50.00	69.75	.19	
63.00	62.98	.13	
80.00	62.46	.39	
100.00	68.27	.19	
125.00	74.57	.05	
160.00	79.73	.42	
200.00	77.78	.15	
250.00	69.84	.11	
315.00	69.84	.20	
400.00	71.10	.08	
500.00	71.45	.15	
630.00	74.83	.11	
800.00	60.01	.59	
1000.00	59.32	1.38	
1250.00	59.32	.64	
1600.00	61.73	2.61	
2000.00	56.08	1.00	
2500.00	53.61	.51	
3150.00	51.31	.38	
4000.00	50.87	.33	
5000.00	49.25	.46	
6300.00	47.33	.25	
8000.00	45.59	.22	
10000.00	44.59	.13	
12500.00	43.72	.13	

Noise levels at time 002:10 min.
Counter started at 85

12.50	41.65	.01	
16.00	43.28	20.00	
20.00	73.46	.90	
25.00	67.44	.66	
31.50	62.56	.79	⌈ These are the ⌉
40.00	67.60	.24	| mean levels for |
50.00	69.70	.21	⌊ the fifth block ⌋
63.00	62.68	.37	
80.00	62.21	.15	
100.00	67.74	.29	
125.00	74.02	.47	
160.00	79.40	.39	
200.00	77.76	.31	
250.00	70.24	.22	
315.00	69.61	.17	
400.00	70.95	.06	
500.00	71.43	.14	
630.00	74.68	.06	
800.00	59.11	.73	
1000.00	57.57	.39	
1250.00	57.30	1.07	
1600.00	62.15	1.28	

```
  2000.00        54.18          .34
  2500.00        52.46          .59
  3150.00        51.19         1.30
  4000.00        50.10          .59
  5000.00        48.70          .74
  6300.00        46.90          .67
  8000.00        44.89          .37
 10000.00        44.27          .24
 12500.00        43.65          .25
```

An example of a main output file for a case of three blocks of data, each with only one sample.

```
Sea noise levels from tape 1/20/1/92

Tape recorder                    : 1234
Calibration spectrum level       : -130.0 (dB re 1V2/Hz @ 1kHz )
Cal source, white, pink or none: Pink noise
Hydrophone sensitivity file      : HYDROPHO.DAT
Calibration gain                 :    .0 (dB)
Sea noise gain                   :    .0 (dB)
Calibration started at counter   :   10 using an 8s sample
Seanoise started at counter      :  245
Total sea noise play time        : 000 min 47 s

Number of channels               =  27
Averaging time                   =   8 s
Number of samples per block      =   1
Total number of blocks           =   3
Time between each block          =  10 s  (manual trigger)
First channel                    =  15

Hydrophone sensitivity
     Freq (Hz)     Sensitivity (dB re 1V/µPa)
       31.50       -195.00          40.00       -195.00
       50.00       -195.00          63.00       -195.00
       80.00       -195.00         100.00       -195.00
      125.00       -195.00         160.00       -195.00
      200.00       -195.00         250.00       -195.00
      315.00       -195.00         400.00       -195.00
      500.00       -195.00         630.00       -195.00
      800.00       -195.00        1000.00       -195.00
     1250.00       -195.00        1600.00       -195.00
     2000.00       -195.00        2500.00       -195.00
     3150.00       -195.00        4000.00       -195.00
     5000.00       -195.00        6300.00       -195.00
     8000.00       -195.00       10000.00       -195.00
    12500.00       -195.00            .00           .00

Calculated mean and standard deviation
     Freq (Hz)     Mean (dB)      Std Dev      Levels at time
       31.50         69.64           .00       000:04 min.
       40.00         66.20           .00
       50.00         62.43           .00
       63.00         60.73           .00  [ These are the mean  ]
       80.00         59.09           .00  | levels for the first block. |
```

```
    100.00          56.52           .00
    125.00          54.95           .00
    160.00          55.58           .00
    200.00          55.61           .00
    250.00          57.04           .00
    315.00          58.24           .00
    400.00          58.70           .00
    500.00          59.03           .00
    630.00          59.53           .00
    800.00          58.29           .00
   1000.00          56.62           .00
   1250.00          54.75           .00
   1600.00          52.58           .00
   2000.00          50.91           .00
   2500.00          49.64           .00
   3150.00          48.24           .00
   4000.00          46.80           .00
   5000.00          46.13           .00
   6300.00          45.03           .00
   8000.00          44.39           .00
  10000.00          44.12           .00
  12500.00          44.45           .00


Noise levels at time 000:23 min.
Counter started at  255
      31.50          64.34           .00
      40.00          61.80           .00
      50.00          61.93           .00
      63.00          58.93           .00
      80.00          57.09           .00
     100.00          55.92           .00
     125.00          54.55           .00
     160.00          55.28           .00
     200.00          57.41           .00
     250.00          56.24           .00
     315.00          55.94           .00
     400.00          55.60           .00
     500.00          55.33           .00
     630.00          54.83           .00
     800.00          53.59           .00
    1000.00          52.12           .00
    1250.00          50.35           .00
    1600.00          48.68           .00
    2000.00          47.61           .00
    2500.00          46.44           .00
    3150.00          45.04           .00
    4000.00          44.00           .00
    5000.00          43.53           .00
    6300.00          43.43           .00
    8000.00          43.39           .00
   10000.00          43.82           .00
   12500.00          44.55           .00

Noise levels at time 000:42 min.
Counter started at  265
      31.50          69.44           .00
      40.00          66.30           .00
      50.00          62.33           .00
```

The STD is 0.0 because there is only one sample per block.

These are the mean levels for the second block

63.00	59.33	.00	⌈ These are the ⌉
80.00	58.19	.00	⌊ mean levels for ⌋
100.00	56.62	.00	⌊ the third block ⌋
125.00	55.45	.00	
160.00	55.18	.00	
200.00	54.51	.00	
250.00	55.14	.00	
315.00	56.74	.00	
400.00	57.80	.00	
500.00	58.33	.00	
630.00	57.63	.00	
800.00	56.69	.00	
1000.00	55.02	.00	
1250.00	53.25	.00	
1600.00	51.58	.00	
2000.00	50.11	.00	
2500.00	49.04	.00	
3150.00	47.84	.00	
4000.00	46.30	.00	
5000.00	45.53	.00	
6300.00	44.83	.00	
8000.00	44.29	.00	
10000.00	44.32	.00	
12500.00	44.85	.00	

An example of a graphics output file, meant for use with a graphics package such as EASYPLOT or GRAPHER. The first column contains the frequencies (Hz), and the second column contains the mean sea noise (dB re 1μPa²/Hz) for a particular block.

50.000000	77.029140
63.000000	77.025440
80.000000	75.987950
100.000000	75.018840
125.000000	74.049740
160.000000	122.977600
200.000000	72.008540
250.000000	71.039440
315.000000	70.035740
400.000000	68.998250
500.000000	68.029140
630.000000	67.025440
800.000000	65.987950
1000.000000	65.018840
1250.000000	64.049740
1600.000000	62.977650
2000.000000	62.008540
2500.000000	61.039440
3150.000000	60.035740
4000.000000	58.998250
5000.000000	58.029140
6300.000000	57.025440
8000.000000	55.987950
10000.000000	55.018840

An example of a record gain output file, meant for use with a graphics package such as EASYPLOT or GRAPHER. The first column contains the frequencies (Hz) and the second column contains the record gain (dB) calculated from the calibration signal.

```
    50.000000       34.663880
    63.000000       34.063870
    80.000000       34.663880
   100.000000       37.663880
   125.000000       33.763880
   160.000000       34.263880
   200.000000       34.763880
   250.000000       33.763880
   315.000000       34.063870
   400.000000       34.263880
   500.000000       34.063870
   630.000000       34.863880
   800.000000       35.263880
  1000.000000       35.763880
  1250.000000       36.763880
  1600.000000       37.663880
  2000.000000       37.863880
  2500.000000       38.763880
  3150.000000       39.163880
  4000.000000       39.063870
  5000.000000       39.463870
  6300.000000       39.463870
  8000.000000       38.963870
 10000.000000       38.963870
```

Appendix D - Graphs Available

There are three graphs possible through B&KNOISE. The first displays the record gain versus frequency. This graph is indicated in Figure D1. This graph is automatically offered to the operator after a calibration measurement.

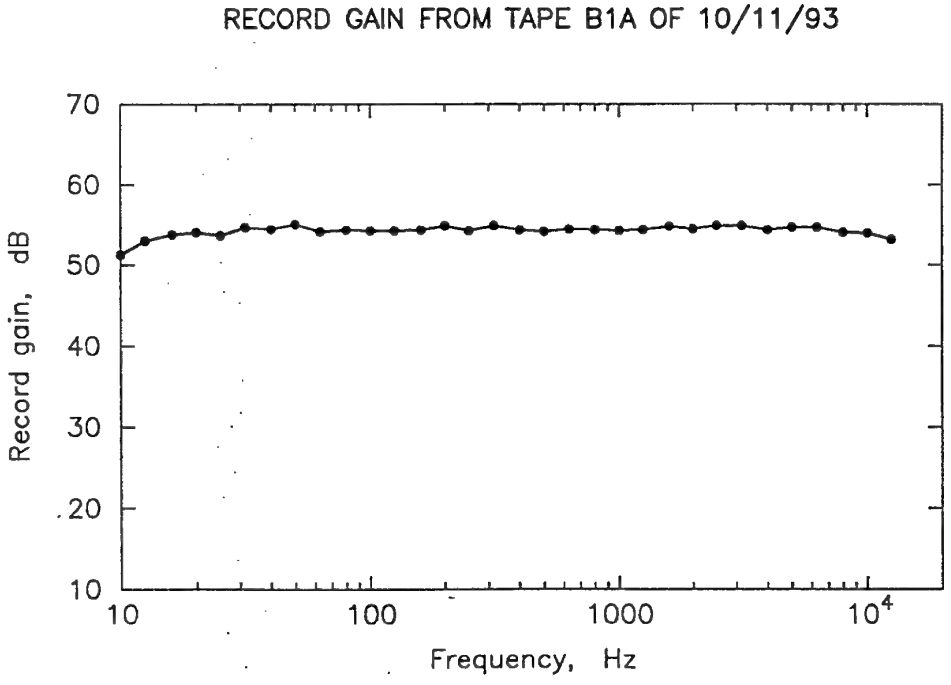

Figure D1 - B&KNOISE graph of record gain versus frequency

The second graph displays the mean versus frequency for a block of data. This graph is indicated in Figure D2 and is obtained by selecting "Graph mean levels versus frequency" in the Graph Menu.

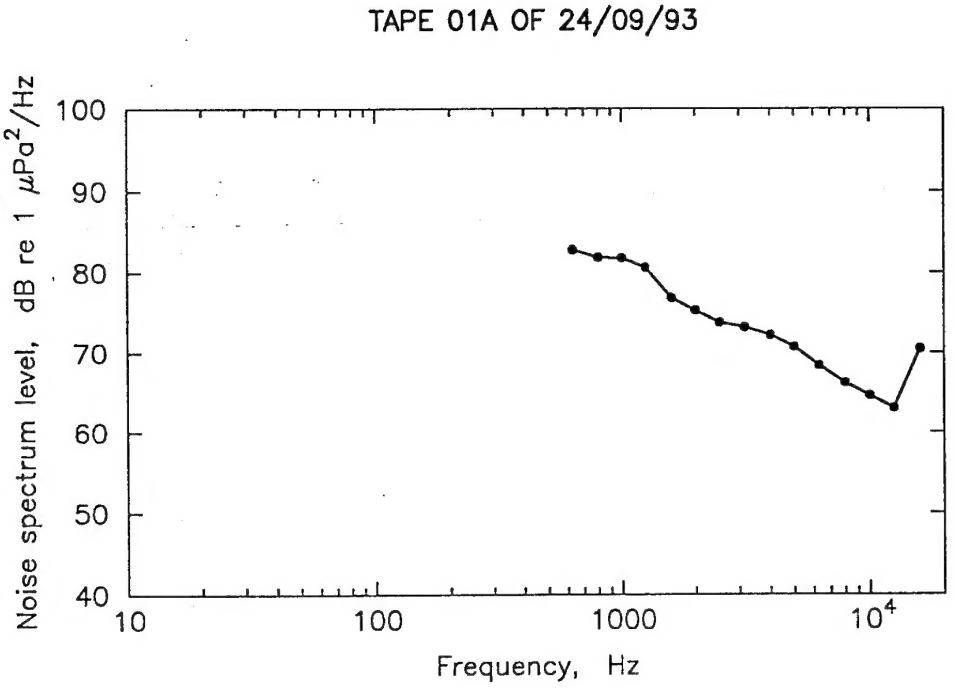

Figure D2 - B&KNOISE graph of mean versus frequency

The third graph displays the mean versus time for a specified frequency. This graph is indicated in Figure D3 and is obtained by selecting "Graph mean levels versus time" in the Graph Menu.

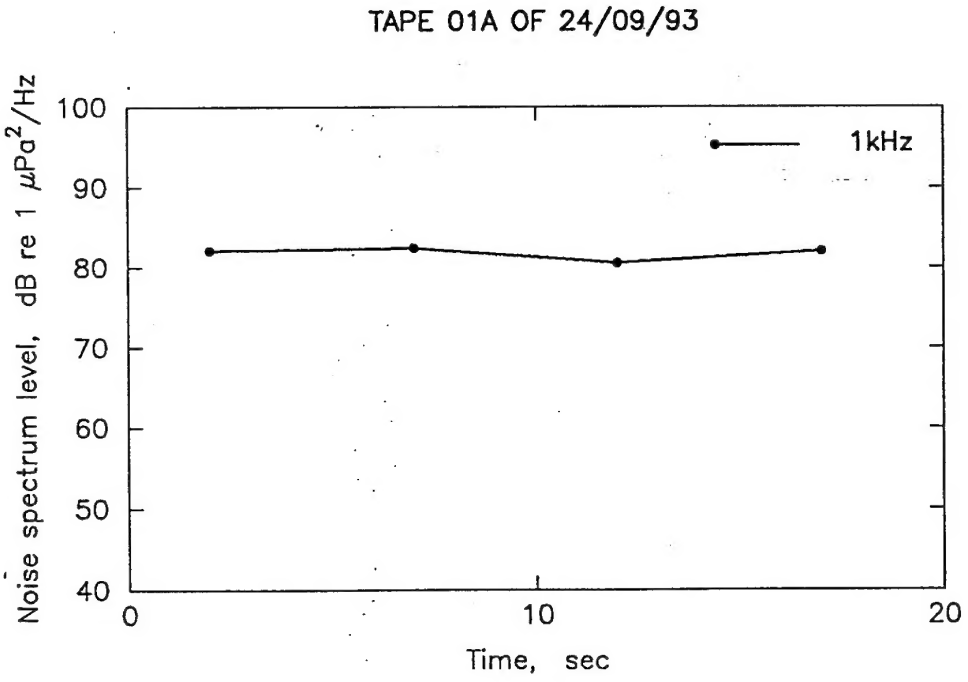

Figure D3 - B&KNOISE graph of mean versus time at a specified frequency

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ABSTRACT

The installation, control and outputs of the program B&KNOISE are described. B&KNOISE is a program designed to analyse sea noise or any other quasi-stationary signal. The program was designed to be user friendly and uses menus to take the operator through the analysis stages. Control of a Bruel and Kjaer 2131 spectrum analyser is handled by B&KNOISE and calculation of the mean and standard deviation are also performed by the program. The output is a number of files that contain the calculated information. Graphs can also be produced by the program.

Manual for the Program B&KNOISE (version 2.0)

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(DSTO-GD-0023)

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